Fig.1

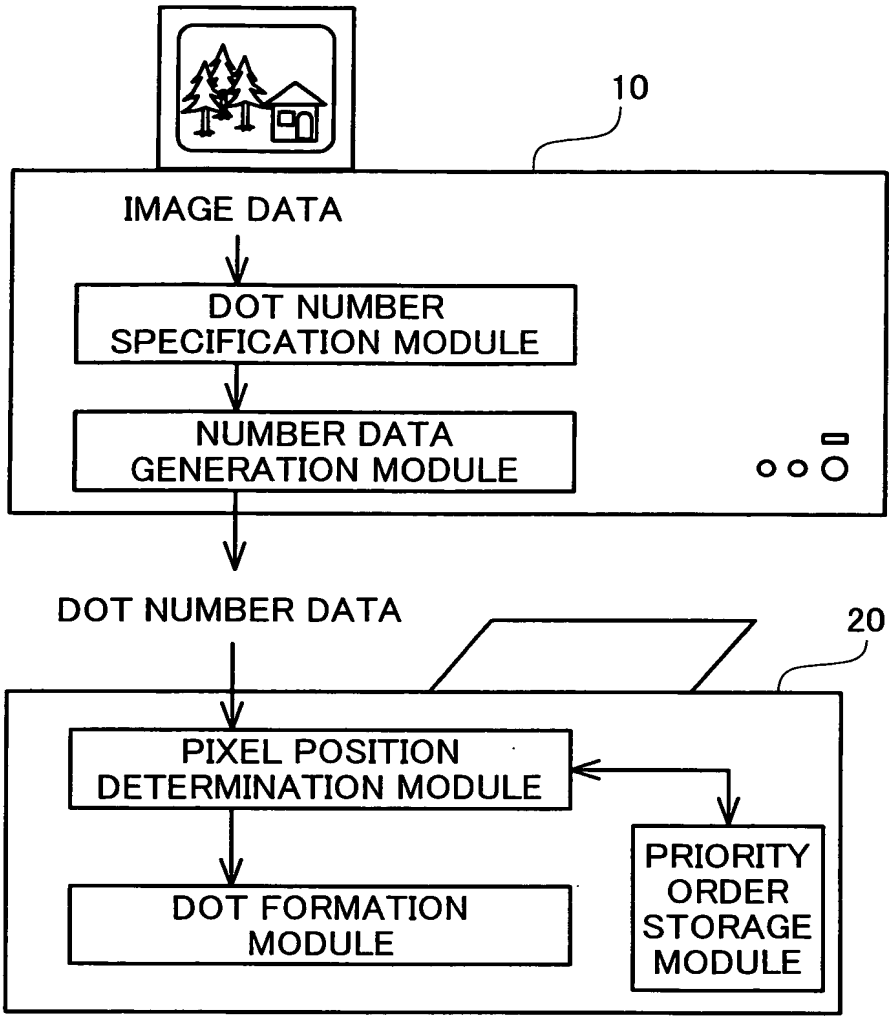

10
IMAGE DATA
DOT NUMBER SPECIFICATION MODULE
NUMBER DATA GENERATION MODULE
DOT NUMBER DATA
20
PIXEL POSITION DETERMINATION MODULE
DOT FORMATION MODULE
PRIORITY ORDER STORAGE MODULE

Fig.2

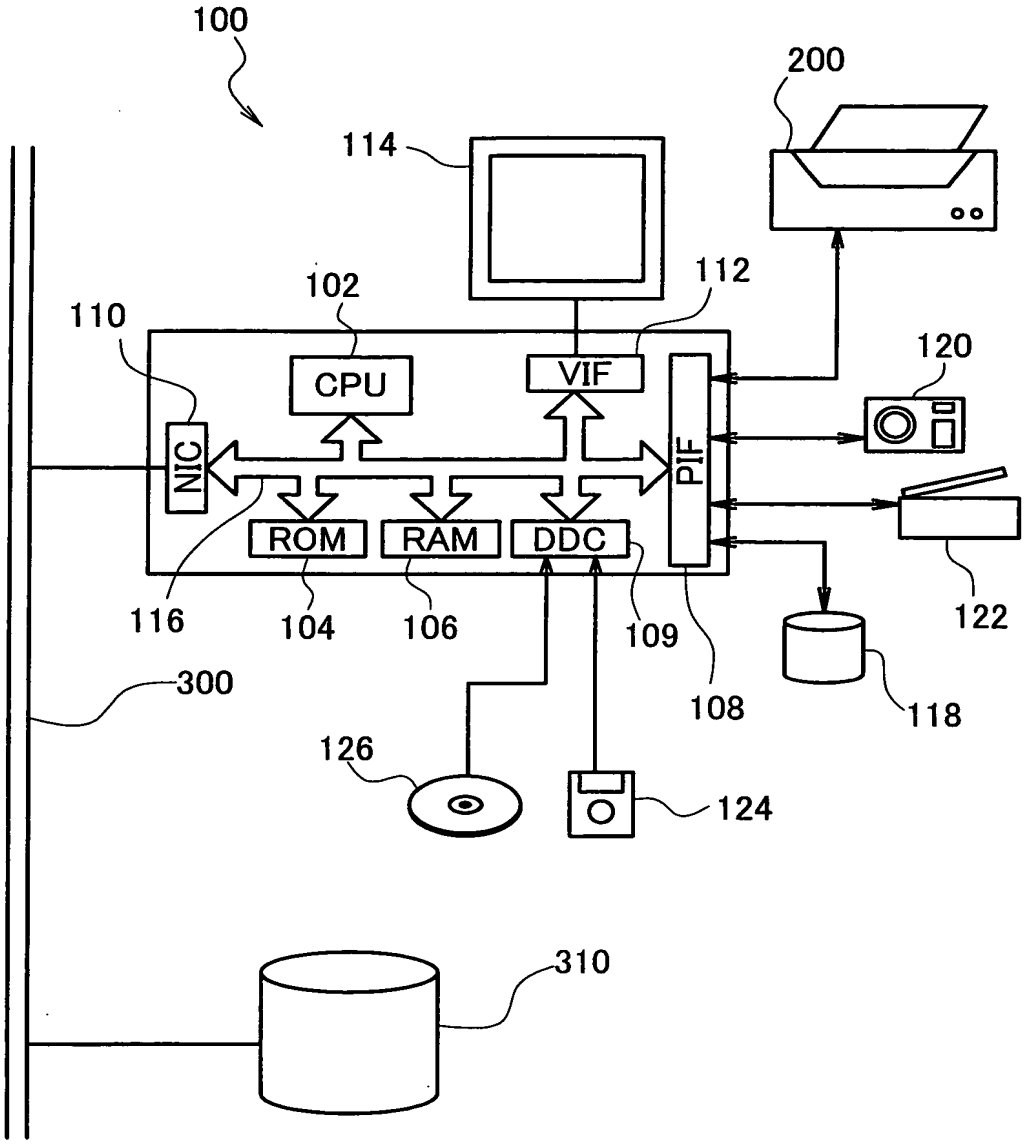

100
200
114
102
112
110
120
CPU
VIF
NIC
PIF
ROM
RAM
DDC
116
104
106
109
108
122
118
300
126
124
310

Fig.3

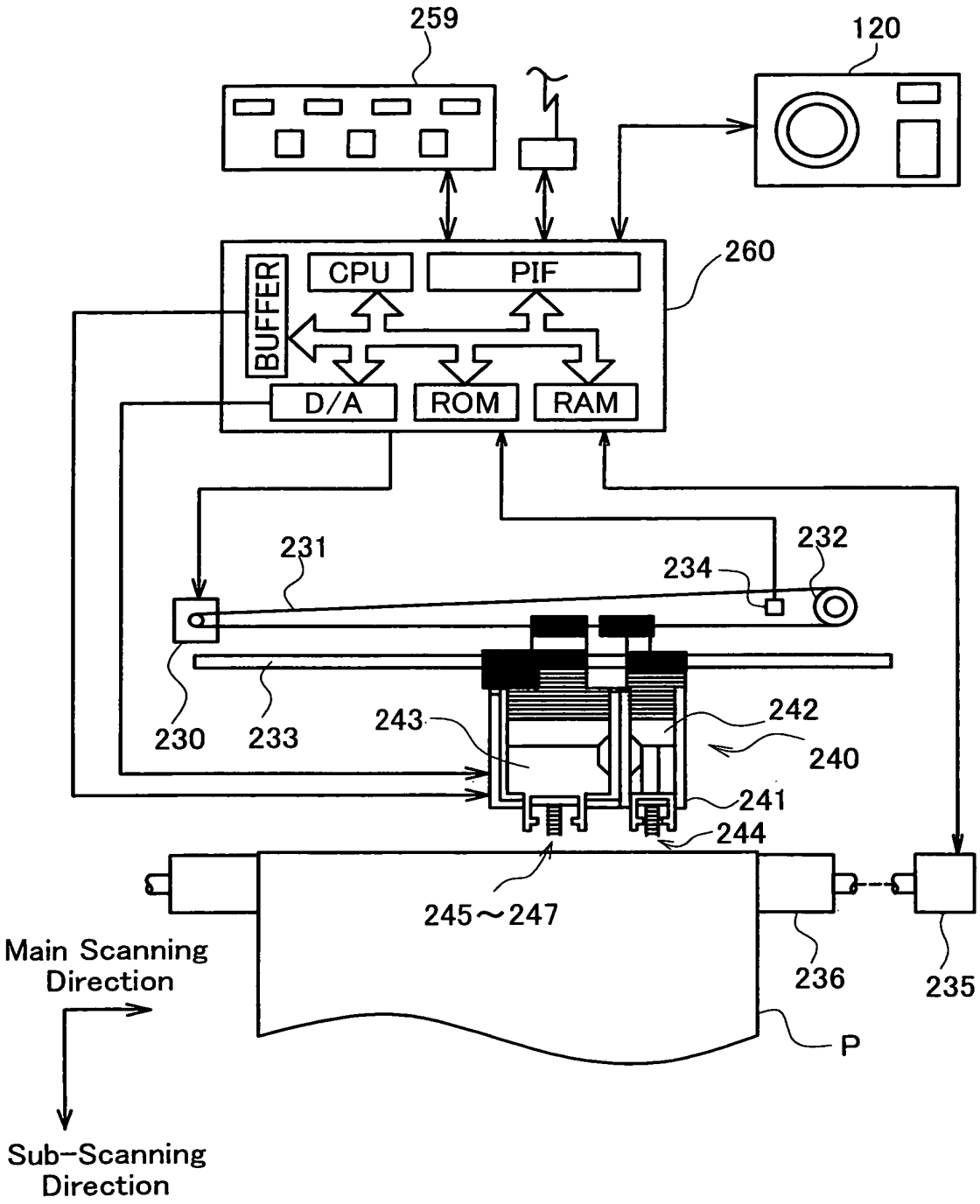

259
120
260
CPU
PIF
BUFFER
D/A
ROM
RAM
231
232
234
230
233
243
242
240
241
244
245～247
236
235
P
Main Scanning Direction
Sub-Scanning Direction

Fig.4

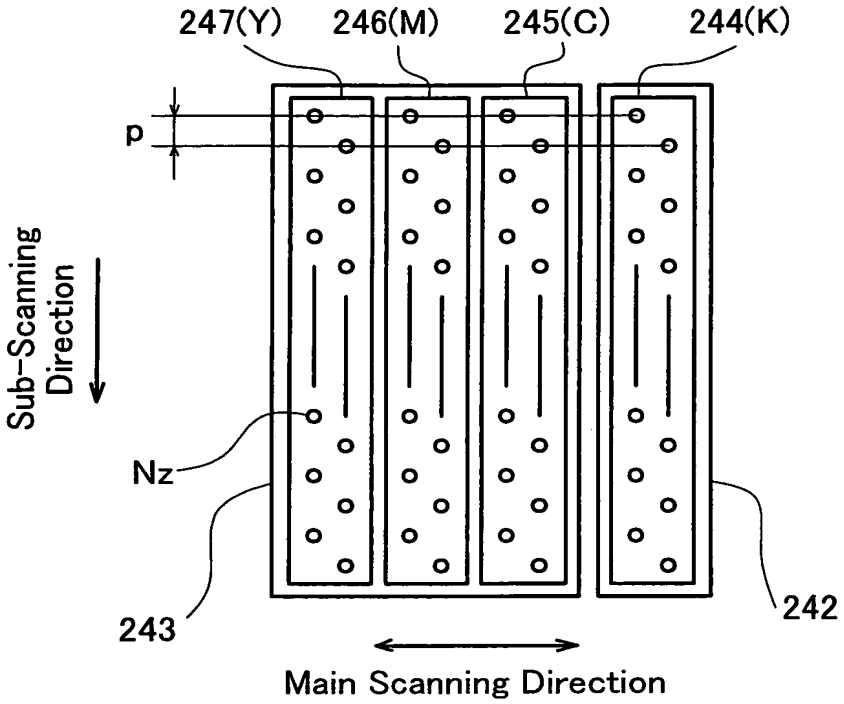

247(Y)
246(M)
245(C)
244(K)
p
Sub-Scanning Direction
Nz
243
242
Main Scanning Direction

Fig.5

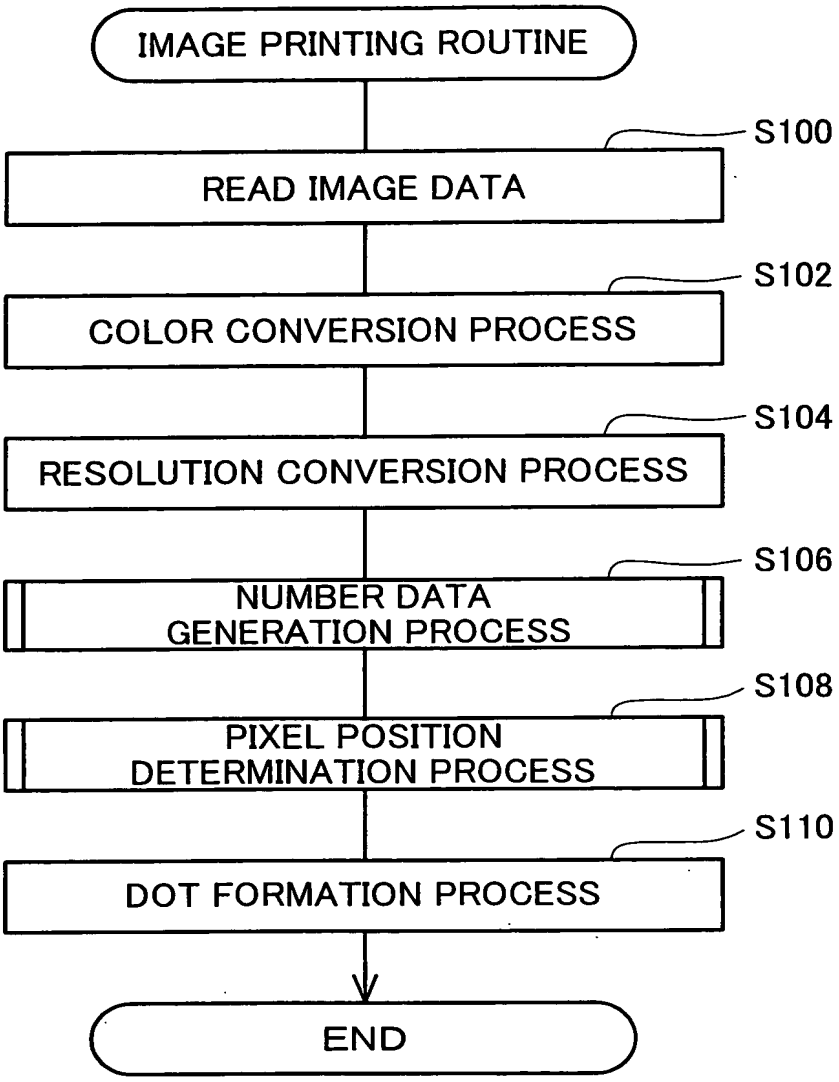


IMAGE PRINTING ROUTINE
S100
READ IMAGE DATA
S102
COLOR CONVERSION PROCESS
S104
RESOLUTION CONVERSION PROCESS
S106
NUMBER DATA GENERATION PROCESS
S108
PIXEL POSITION DETERMINATION PROCESS
S110
DOT FORMATION PROCESS
END

Fig.6(a)

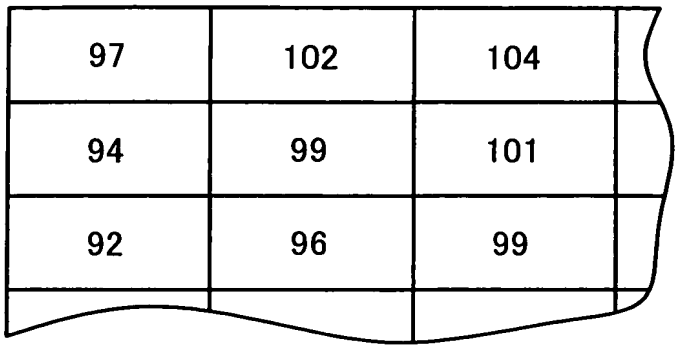

97
102
104
94
99
101
92
96
99

Fig.6(b)

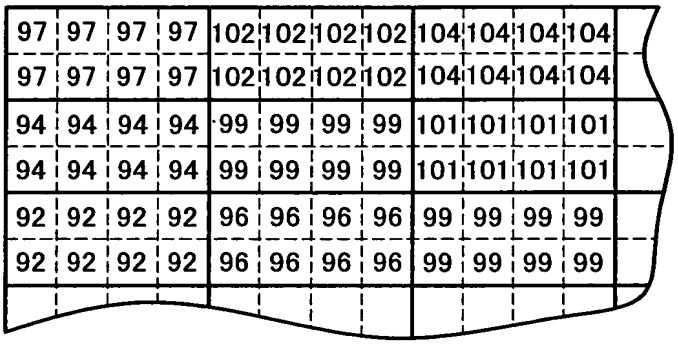

97 97 97 97 102 102 102 102 104 104 104 104
97 97 97 97 102 102 102 102 104 104 104 104
94 94 94 94 99 99 99 99 101 101 101 101
94 94 94 94 99 99 99 99 101 101 101 101
92 92 92 92 96 96 96 96 99 99 99 99
92 92 92 92 96 96 96 96 99 99 99 99

Fig.7

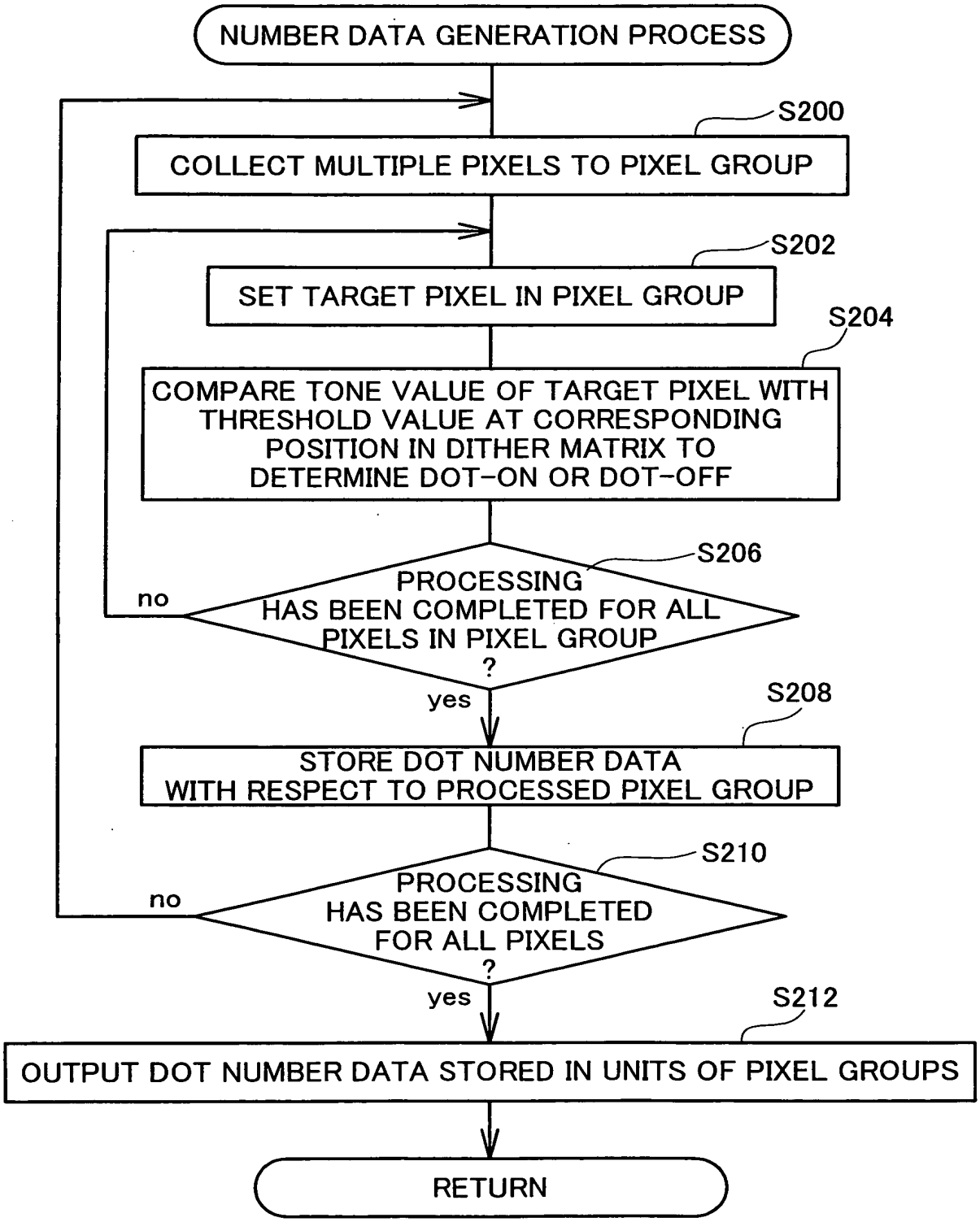
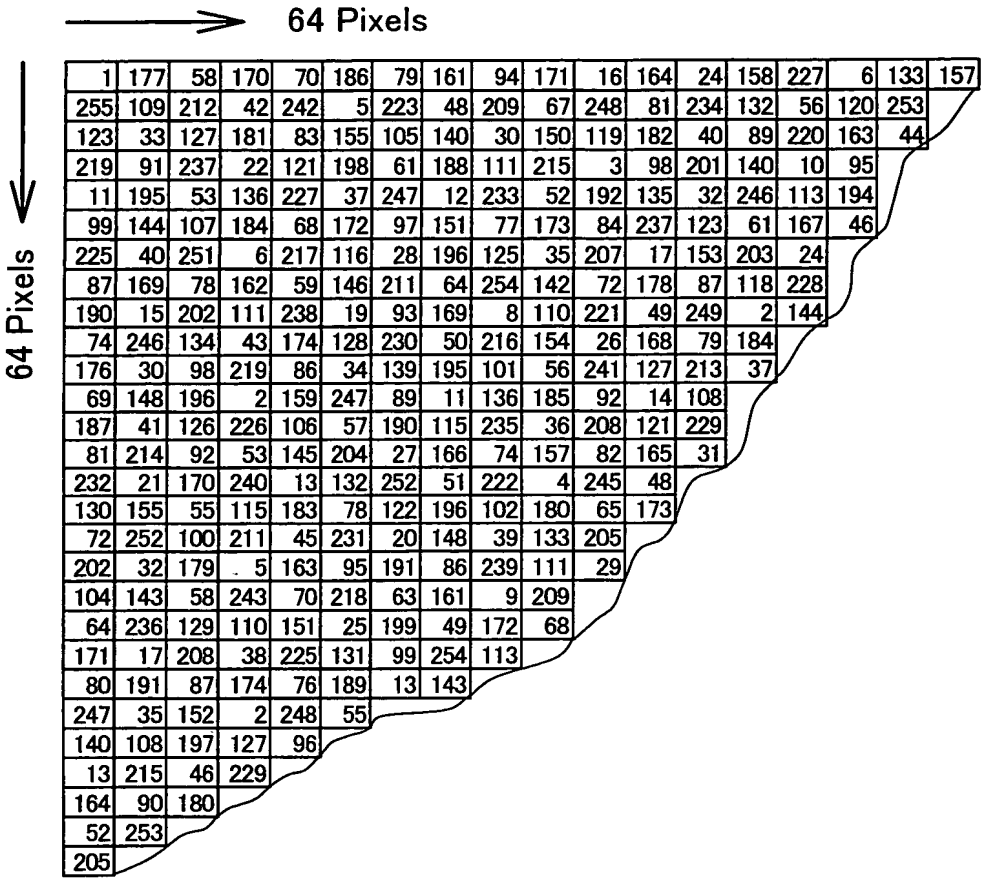

NUMBER DATA GENERATION PROCESS
S200
COLLECT MULTIPLE PIXELS TO PIXEL GROUP
S202
SET TARGET PIXEL IN PIXEL GROUP
S204
COMPARE TONE VALUE OF TARGET PIXEL WITH THRESHOLD VALUE AT CORRESPONDING POSITION IN DITHER MATRIX TO DETERMINE DOT-ON OR DOT-OFF
S206
PROCESSING HAS BEEN COMPLETED FOR ALL PIXELS IN PIXEL GROUP ?
no
yes
S208
STORE DOT NUMBER DATA WITH RESPECT TO PROCESSED PIXEL GROUP
S210
PROCESSING HAS BEEN COMPLETED FOR ALL PIXELS ?
no
yes
S212
OUTPUT DOT NUMBER DATA STORED IN UNITS OF PIXEL GROUPS
RETURN

Fig.8



1	177	58	170	70	186	79	161	94	171	16	164	24	158	227	6	133	157
255	109	212	42	242	5	223	48	209	67	248	81	234	132	56	120	253	
123	33	127	181	83	155	105	140	30	150	119	182	40	89	220	163	44	
219	91	237	22	121	198	61	188	111	215	3	98	201	140	10	95		
11	195	53	136	227	37	247	12	233	52	192	135	32	246	113	194		
99	144	107	184	68	172	97	151	77	173	84	237	123	61	167	46		
225	40	251	6	217	116	28	196	125	35	207	17	153	203	24			
87	169	78	162	59	146	211	64	254	142	72	178	87	118	228			
190	15	202	111	238	19	93	169	8	110	221	49	249	2	144			
74	246	134	43	174	128	230	50	216	154	26	168	79	184				
176	30	98	219	86	34	139	195	101	56	241	127	213	37				
69	148	196	2	159	247	89	11	136	185	92	14	108					
187	41	126	226	106	57	190	115	235	36	208	121	229					
81	214	92	53	145	204	27	166	74	157	82	165	31					
232	21	170	240	13	132	252	51	222	4	245	48						
130	155	55	115	183	78	122	196	102	180	65	173						
72	252	100	211	45	231	20	148	39	133	205							
202	32	179	5	163	95	191	86	239	111	29							
104	143	58	243	70	218	63	161	9	209								
64	236	129	110	151	25	199	49	172	68								
171	17	208	38	225	131	99	254	113									
80	191	87	174	76	189	13	143										
247	35	152	2	248	55												
140	108	197	127	96													
13	215	46	229														
164	90	180															
52	253																
205																	

Fig.9

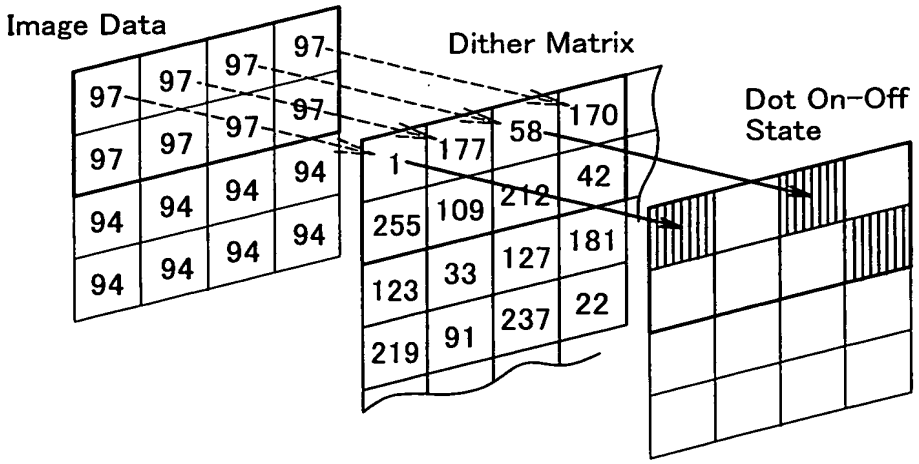


Fig.10(a)

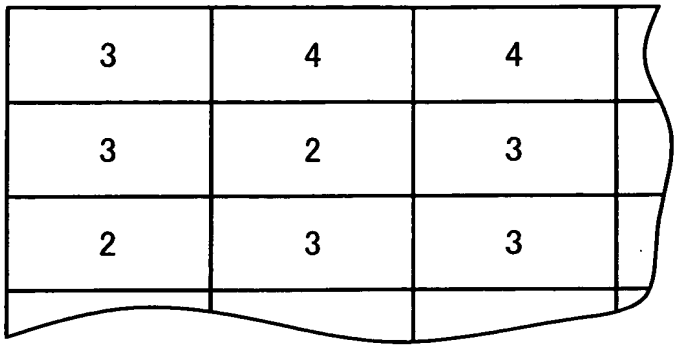


Fig.10(b)

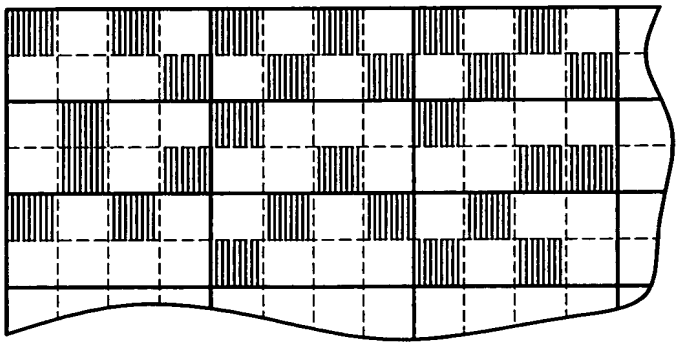


Fig.11

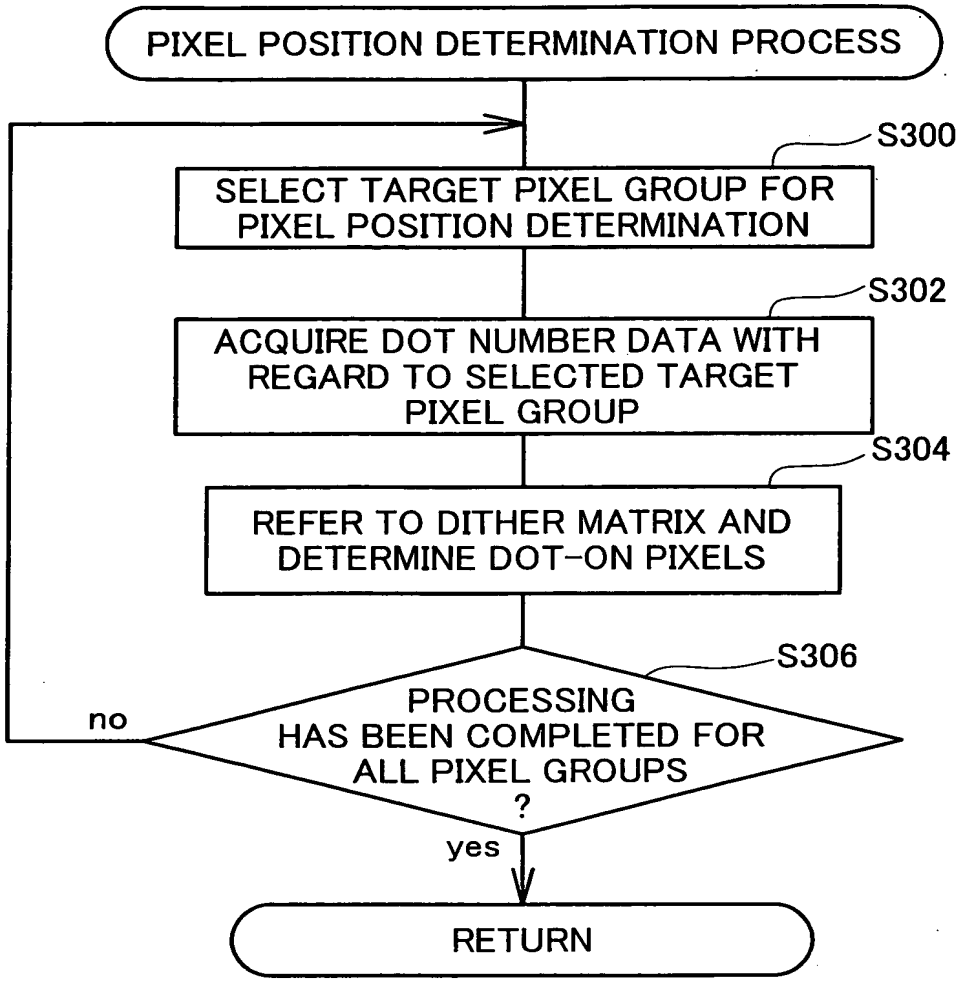

PIXEL POSITION DETERMINATION PROCESS
S300
SELECT TARGET PIXEL GROUP FOR PIXEL POSITION DETERMINATION
S302
ACQUIRE DOT NUMBER DATA WITH REGARD TO SELECTED TARGET PIXEL GROUP
S304
REFER TO DITHER MATRIX AND DETERMINE DOT-ON PIXELS
S306
PROCESSING HAS BEEN COMPLETED FOR ALL PIXEL GROUPS ?
no
yes
RETURN

Fig.12(a)

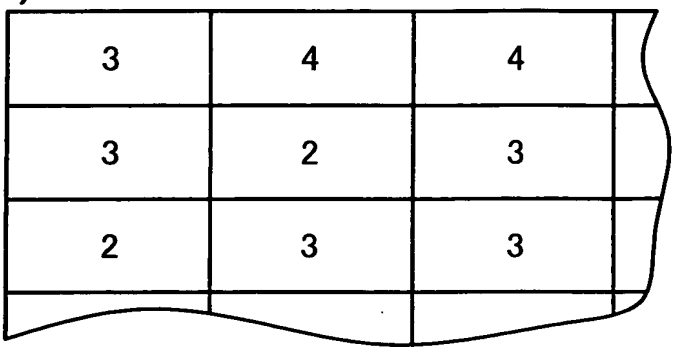


Fig.12(b)

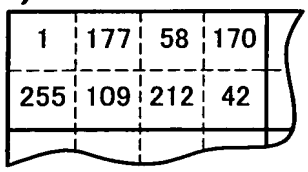


Fig.12(c)

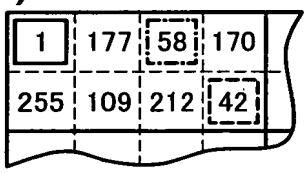


Fig.12(d)

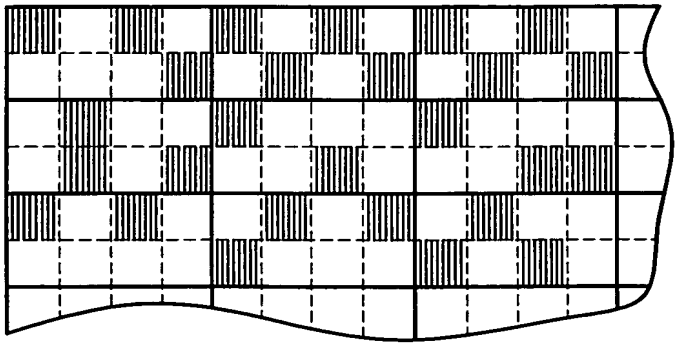


Fig.13(a)

255,212,177,170, 109, 58, 42, 1	242,223,186,161, 79,70,48,5	248,209,171,164, 94,81,67,16
237,219,181,127, 123,91,33,22	198,188,155,140, 121,105,83,61	215,182,150,119, 111,98,30,3
195,184,144,136, 107,99,53,11	247,227,172,151, 97,68,37,12	237,233,192,173, 135,84,77,52

Fig.13(b)

255,212,177,170, 109,58, 42, 1	242,223,186,161, 79, 70, 48, 5	248,209,171,164, 94, 81, 67, 16
237,219,181,127, 123,91, 33, 22	198,188,155,140, 121,105,83, 61	215,182,150,119, 111,98, 30, 3
195,184,144,136, 107,99, 53, 11	247,227,172,151, 97,68, 37, 12	237,233,192,173, 135,84, 77, 52

Fig.13(c)

3	4	4	
3	2	3	
2	3	3	

Fig.14(a)

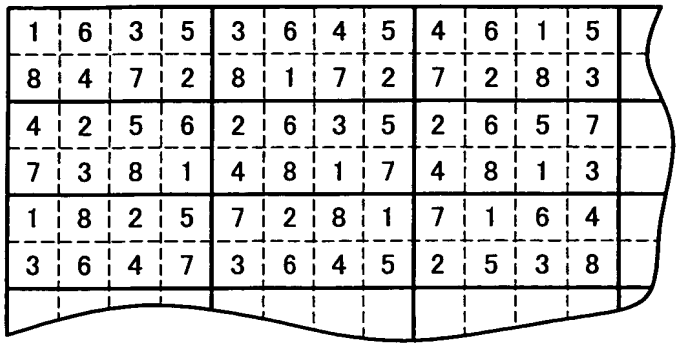


Fig.14(b)

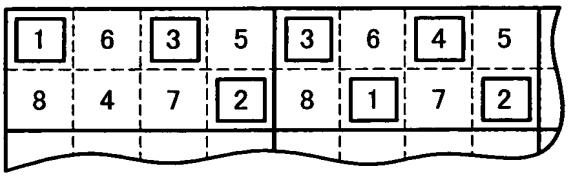


Fig.14(c)

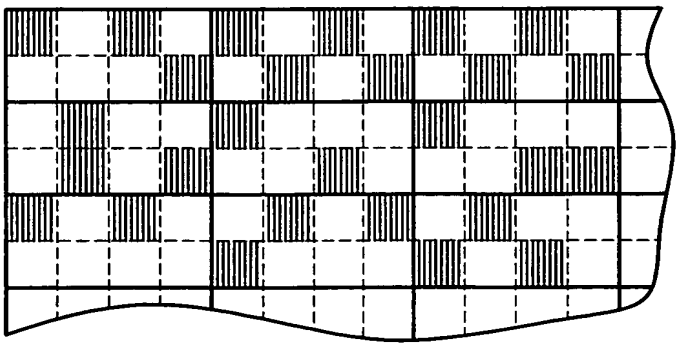


Fig.15

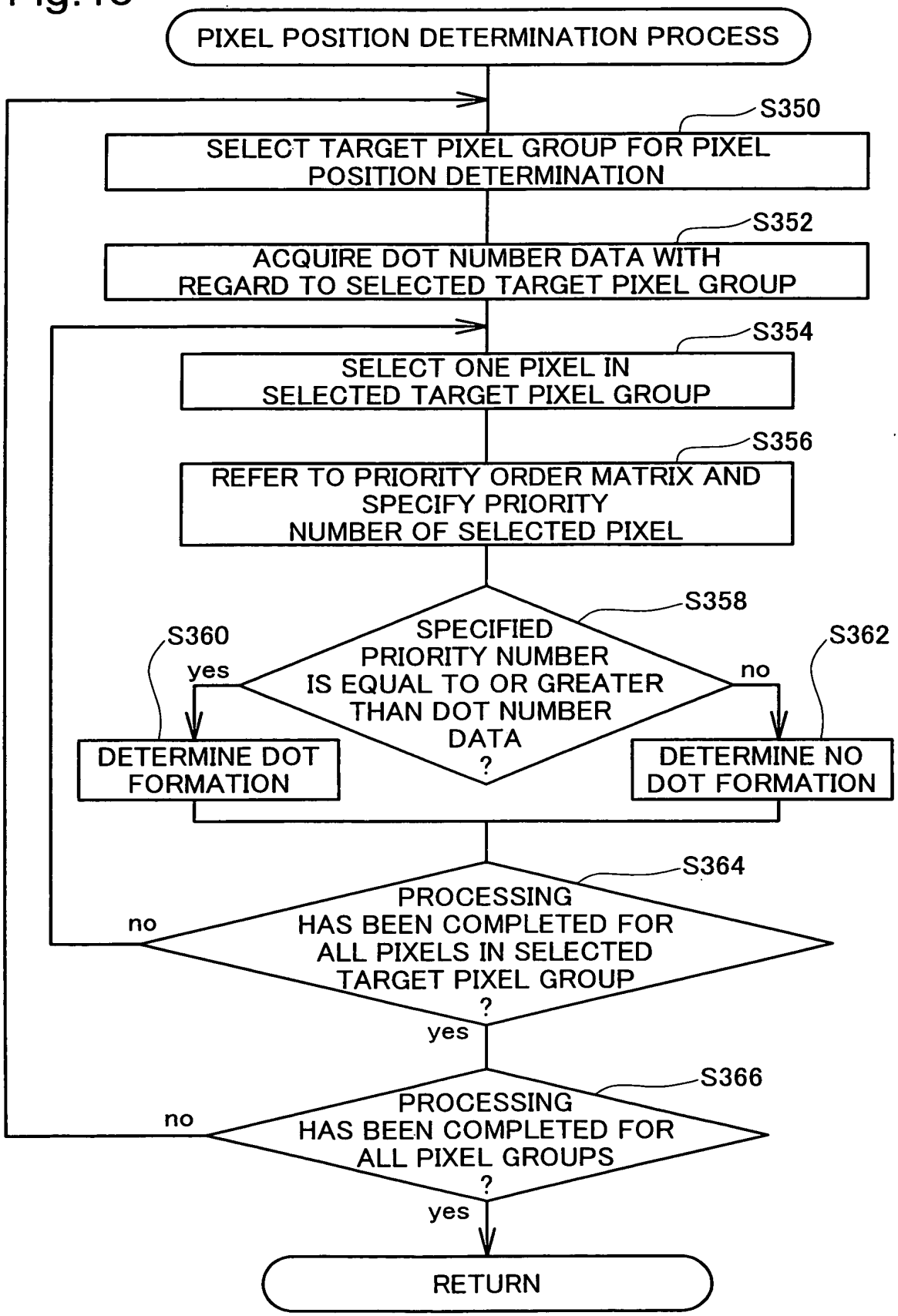

PIXEL POSITION DETERMINATION PROCESS
S350
SELECT TARGET PIXEL GROUP FOR PIXEL POSITION DETERMINATION
S352
ACQUIRE DOT NUMBER DATA WITH REGARD TO SELECTED TARGET PIXEL GROUP
S354
SELECT ONE PIXEL IN SELECTED TARGET PIXEL GROUP
S356
REFER TO PRIORITY ORDER MATRIX AND SPECIFY PRIORITY NUMBER OF SELECTED PIXEL
S358
SPECIFIED PRIORITY NUMBER IS EQUAL TO OR GREATER THAN DOT NUMBER DATA ?
S360
yes
DETERMINE DOT FORMATION
S362
no
DETERMINE NO DOT FORMATION
S364
PROCESSING HAS BEEN COMPLETED FOR ALL PIXELS IN SELECTED TARGET PIXEL GROUP ?
no
yes
S366
PROCESSING HAS BEEN COMPLETED FOR ALL PIXEL GROUPS ?
no
yes
RETURN

Fig.16

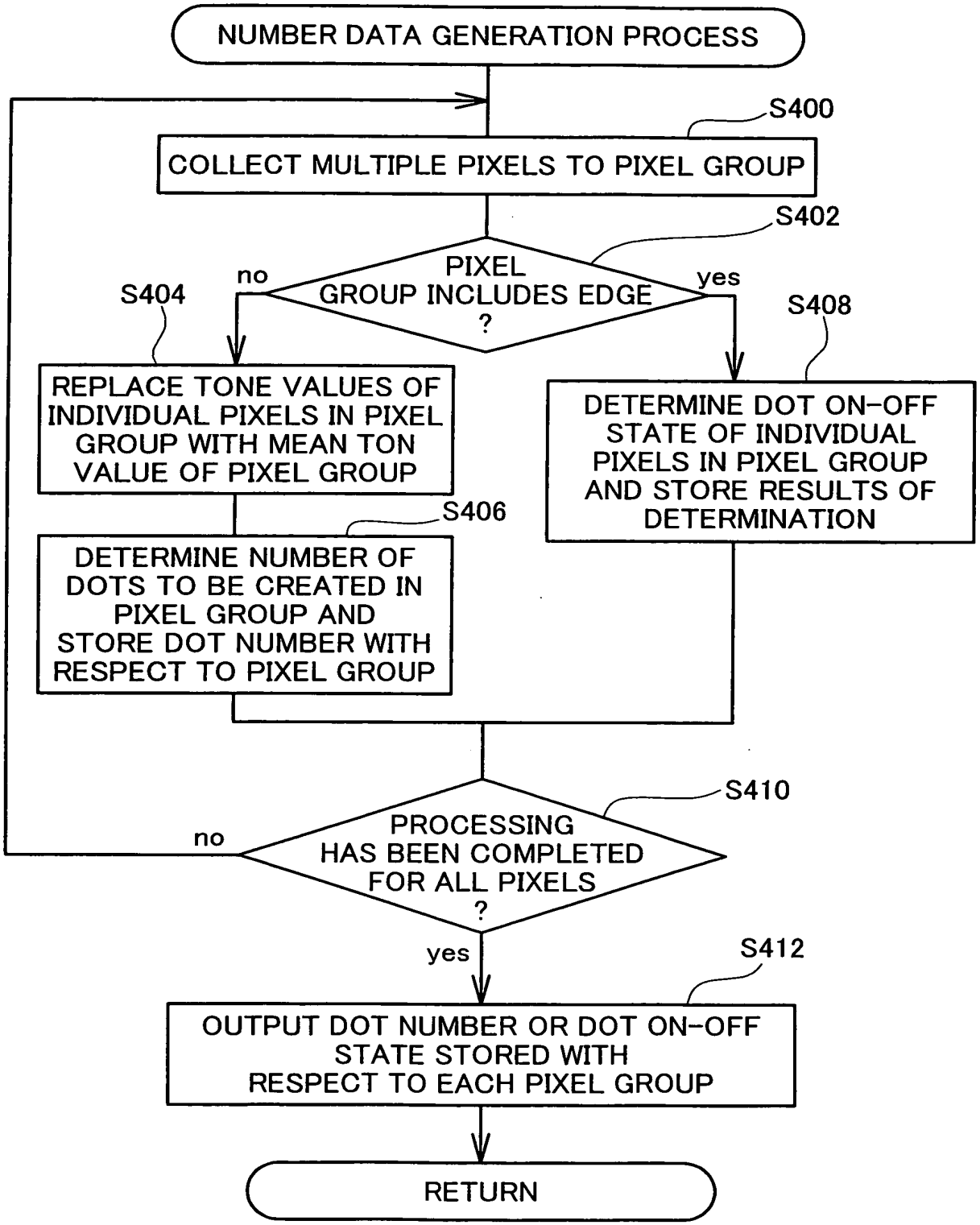

NUMBER DATA GENERATION PROCESS
S400
COLLECT MULTIPLE PIXELS TO PIXEL GROUP
S402
PIXEL GROUP INCLUDES EDGE ?
no
yes
S404
S408
REPLACE TONE VALUES OF INDIVIDUAL PIXELS IN PIXEL GROUP WITH MEAN TON VALUE OF PIXEL GROUP
DETERMINE DOT ON-OFF STATE OF INDIVIDUAL PIXELS IN PIXEL GROUP AND STORE RESULTS OF DETERMINATION
S406
DETERMINE NUMBER OF DOTS TO BE CREATED IN PIXEL GROUP AND STORE DOT NUMBER WITH RESPECT TO PIXEL GROUP
S410
PROCESSING HAS BEEN COMPLETED FOR ALL PIXELS ?
no
yes
S412
OUTPUT DOT NUMBER OR DOT ON-OFF STATE STORED WITH RESPECT TO EACH PIXEL GROUP
RETURN

Fig.17(a)

97	100	97	99	102	104	101	103
98	99	100	98	103	102	104	101
94	96	95	93	99	102	129	130
93	95	94	94	101	100	132	131

Fig.17(b)

<table>
<tr><td>99</td><td colspan="4">103</td></tr>
<tr><td rowspan="2">94</td><td>99</td><td>102</td><td>129</td><td>130</td></tr>
<tr><td>101</td><td>100</td><td>132</td><td>131</td></tr>
</table>

Fig.18(a)

Fig.18(b)

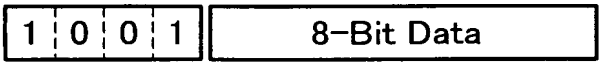


Fig.18(c)

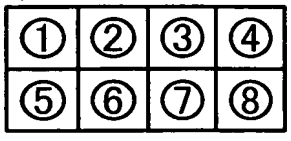


Fig.19

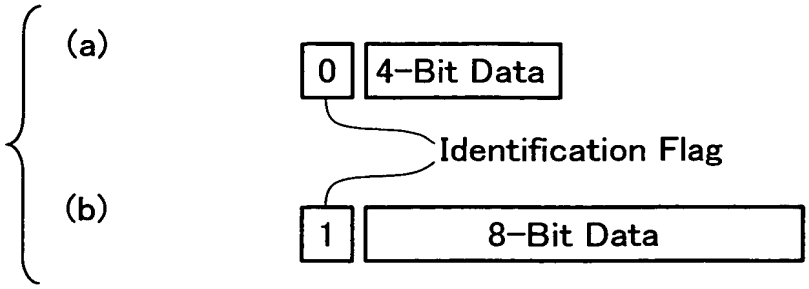

(a)
0
4-Bit Data
Identification Flag
(b)
1
8-Bit Data

Fig.20

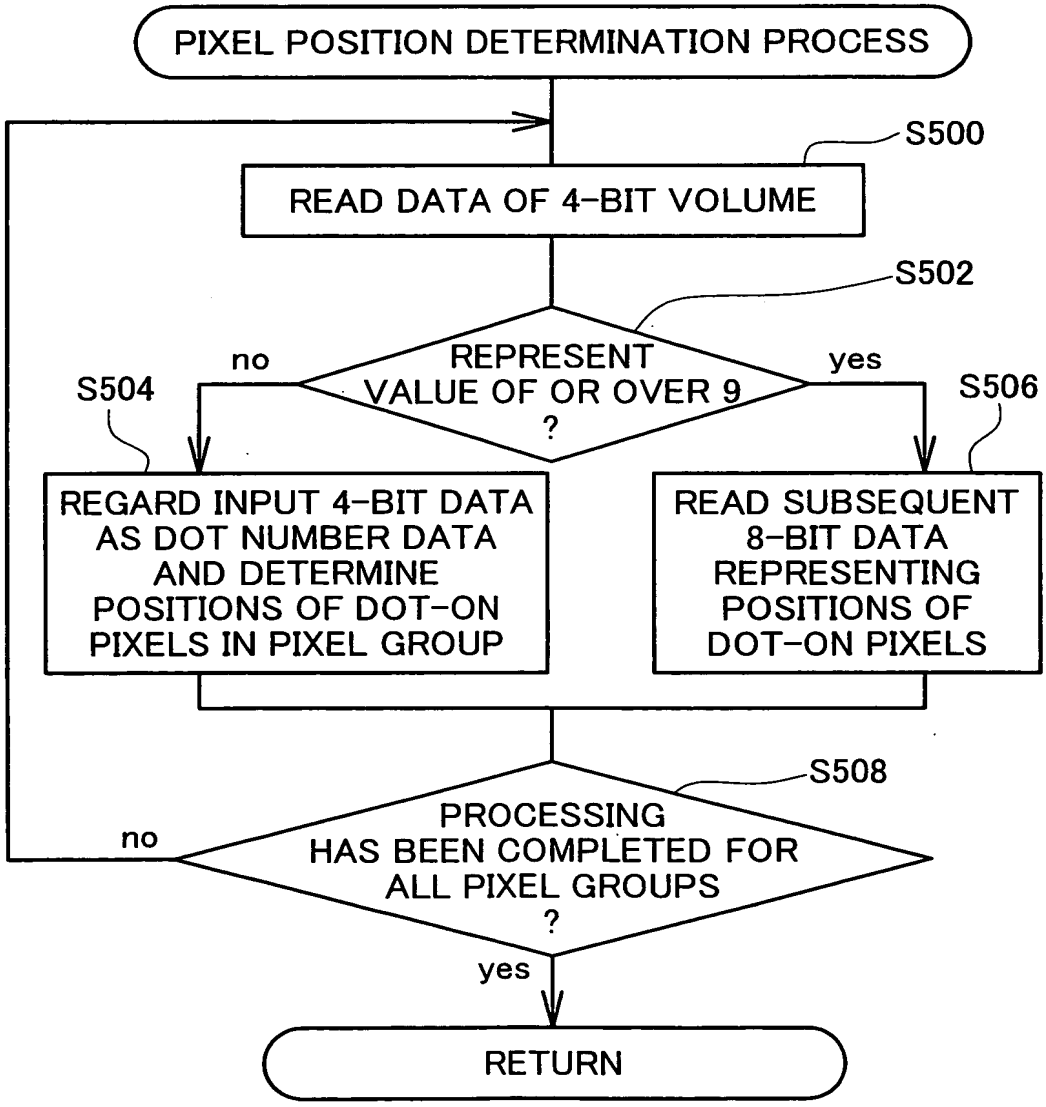

PIXEL POSITION DETERMINATION PROCESS
S500
READ DATA OF 4-BIT VOLUME
S502
REPRESENT VALUE OF OR OVER 9 ?
no
yes
S504
S506
REGARD INPUT 4-BIT DATA AS DOT NUMBER DATA AND DETERMINE POSITIONS OF DOT-ON PIXELS IN PIXEL GROUP
READ SUBSEQUENT 8-BIT DATA REPRESENTING POSITIONS OF DOT-ON PIXELS
S508
PROCESSING HAS BEEN COMPLETED FOR ALL PIXEL GROUPS ?
no
yes
RETURN

Fig.21

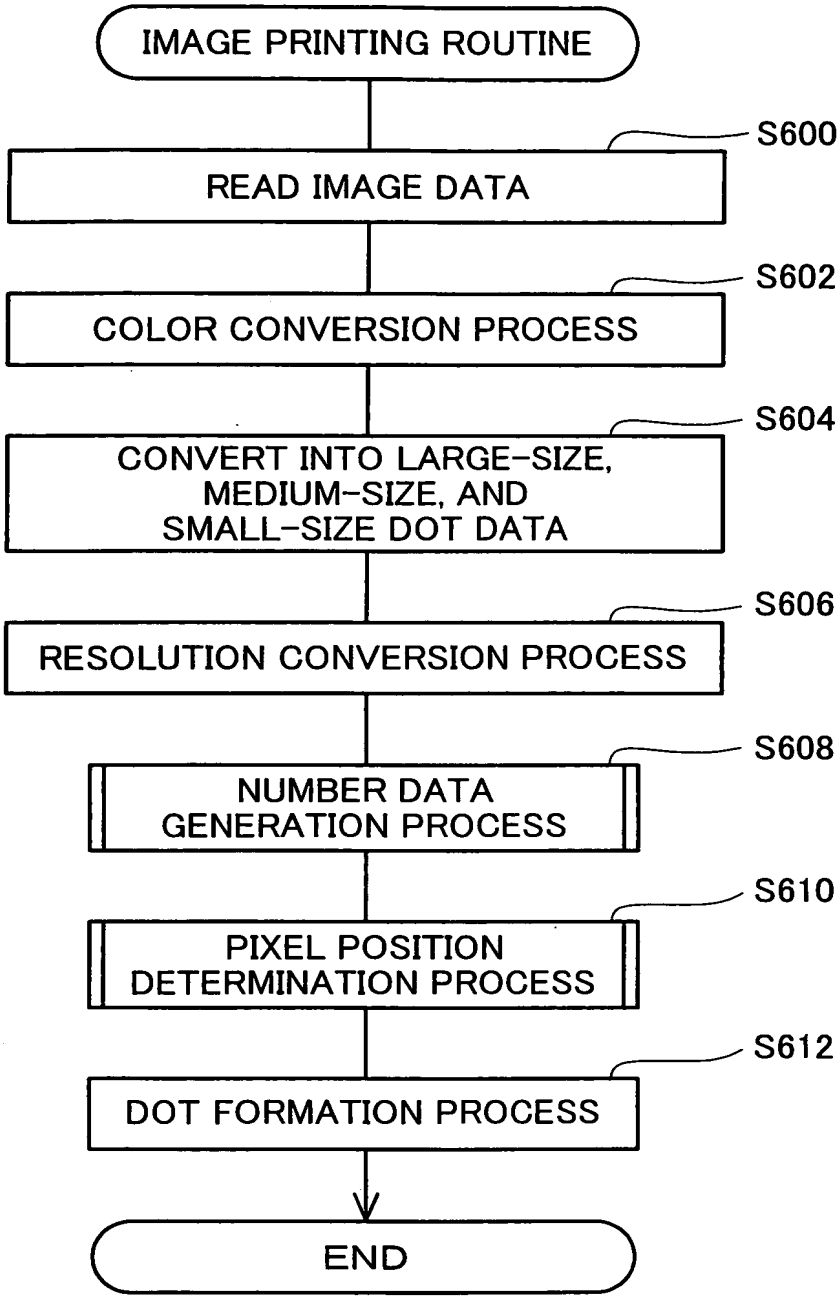


IMAGE PRINTING ROUTINE
S600
READ IMAGE DATA
S602
COLOR CONVERSION PROCESS
S604
CONVERT INTO LARGE-SIZE, MEDIUM-SIZE, AND SMALL-SIZE DOT DATA
S606
RESOLUTION CONVERSION PROCESS
S608
NUMBER DATA GENERATION PROCESS
S610
PIXEL POSITION DETERMINATION PROCESS
S612
DOT FORMATION PROCESS
END

Fig.22

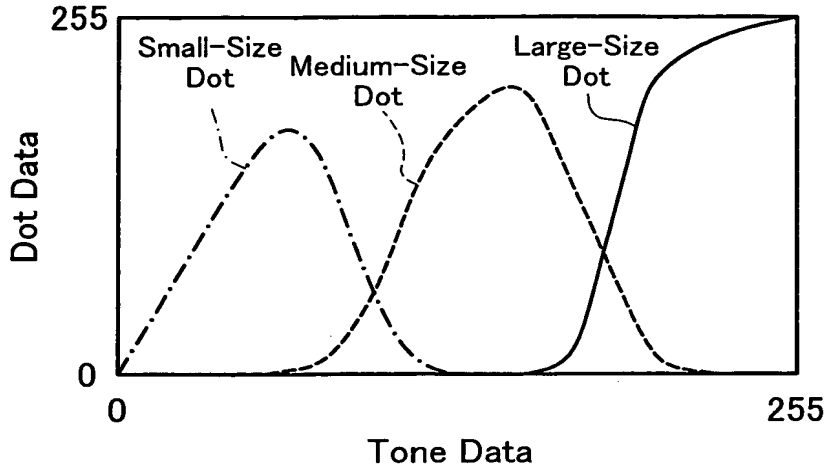


Fig.23(a)

Data(L,M,S) =(2,90,32)	(0,90,40)	(0,85,50)	
(0,92,28)	(5,80,32)	(10,50,32)	
(5,85,52)	(15,60,43)	(20,70,32)	

Fig.23(b)

Dot(L,M,S) = (1,2,1)	(0,4,0)	(0,3,1)	
(0,3,0)	(0,2,1)	(1,1,0)	
(0,2,3)	(1,2,1)	(0,3,0)	

Fig.24

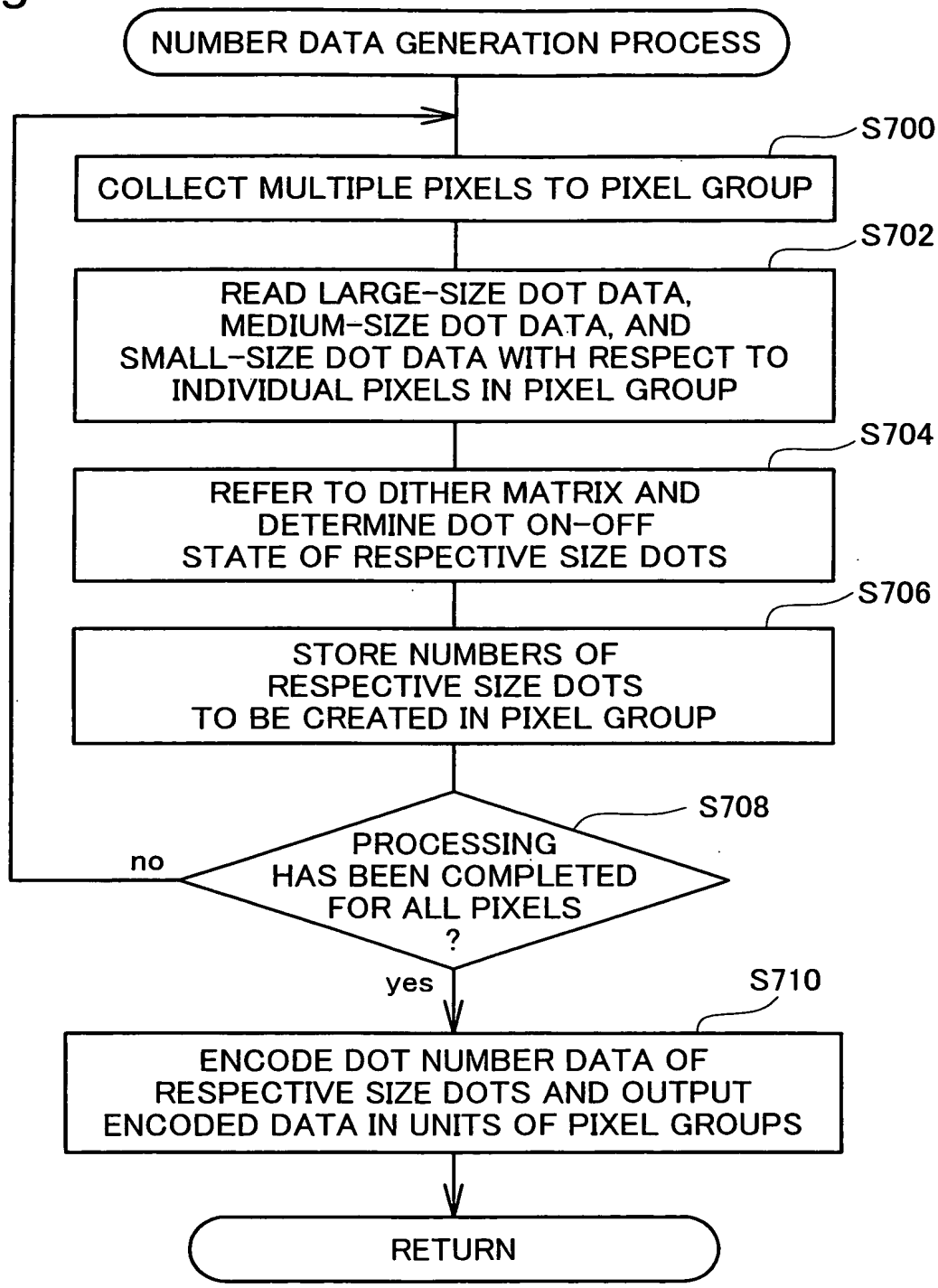

NUMBER DATA GENERATION PROCESS
S700
COLLECT MULTIPLE PIXELS TO PIXEL GROUP
S702
READ LARGE-SIZE DOT DATA, MEDIUM-SIZE DOT DATA, AND SMALL-SIZE DOT DATA WITH RESPECT TO INDIVIDUAL PIXELS IN PIXEL GROUP
S704
REFER TO DITHER MATRIX AND DETERMINE DOT ON-OFF STATE OF RESPECTIVE SIZE DOTS
S706
STORE NUMBERS OF RESPECTIVE SIZE DOTS TO BE CREATED IN PIXEL GROUP
S708
PROCESSING HAS BEEN COMPLETED FOR ALL PIXELS ?
no
yes
S710
ENCODE DOT NUMBER DATA OF RESPECTIVE SIZE DOTS AND OUTPUT ENCODED DATA IN UNITS OF PIXEL GROUPS
RETURN

Fig.25

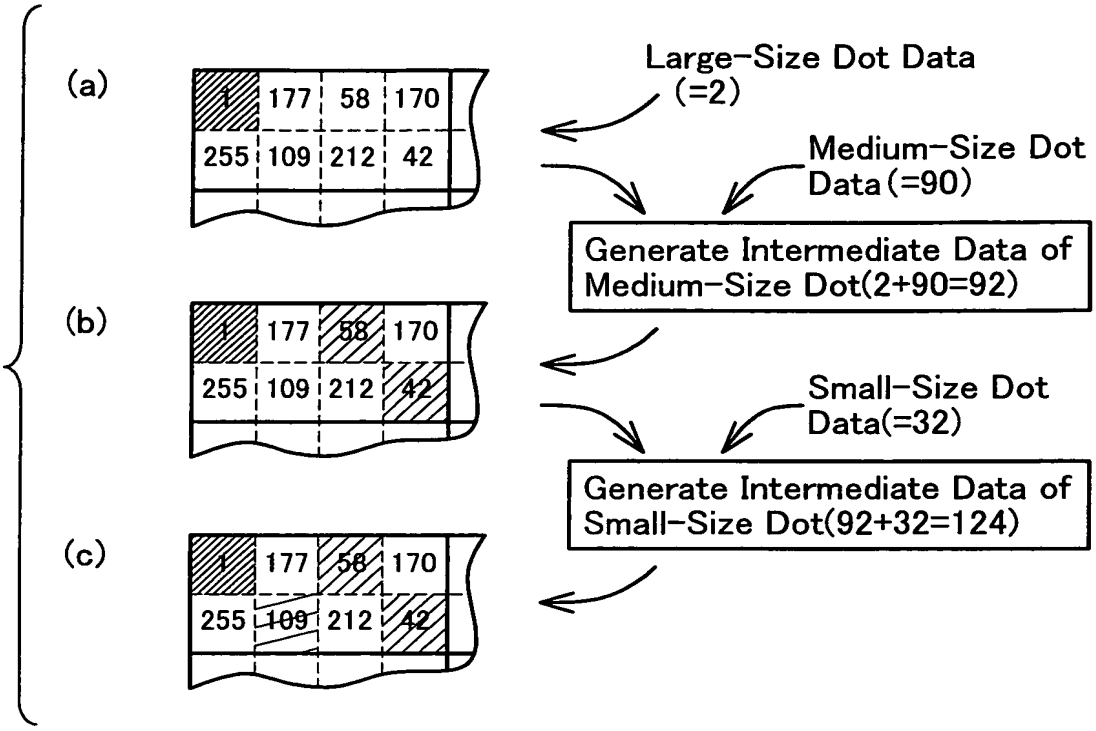


Fig.26

Dot Numbers			
Small-Size Dot	Medium-Size Dot	Large-Size Dot	Code Number
0	0	0	0
1	0	0	1
2	0	0	2
3	0	0	3
0	2	6	160
0	0	7	161
1	0	7	162
0	1	7	163
0	0	8	164

Fig.27

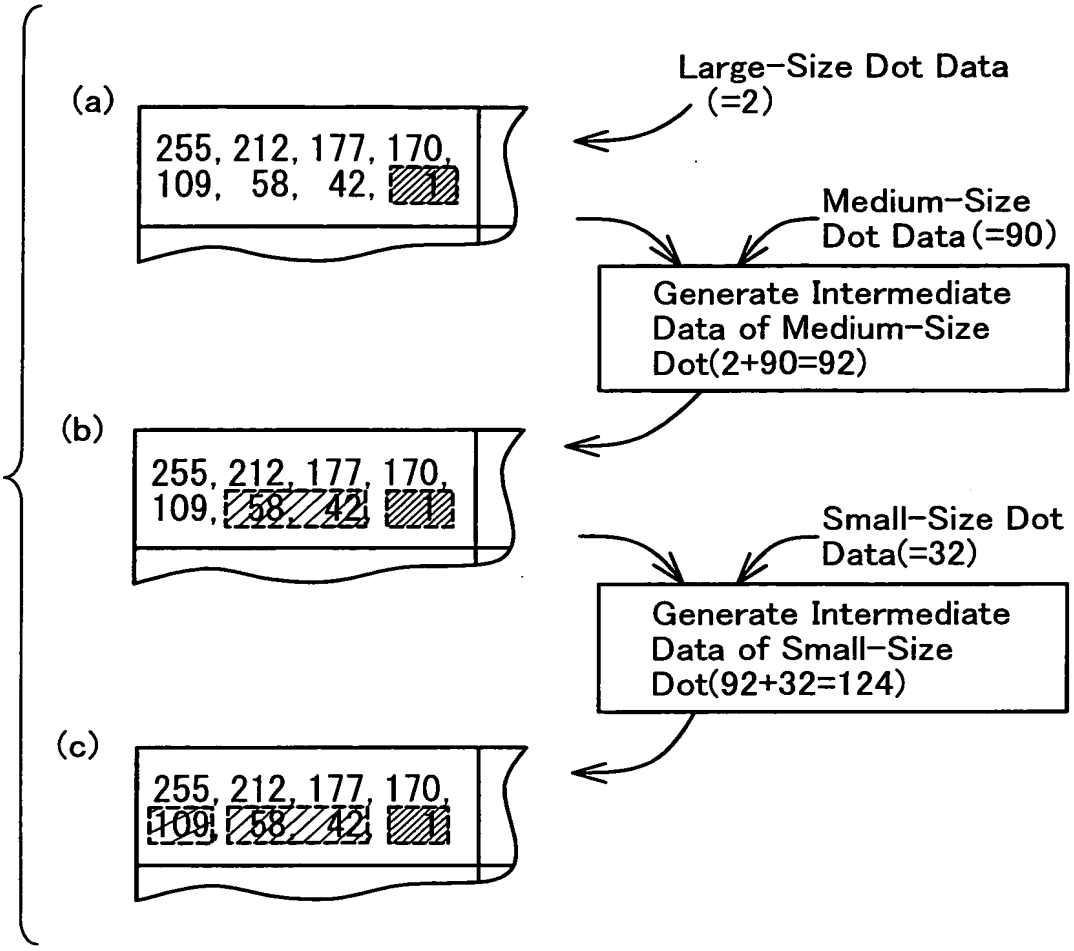

(a)
255, 212, 177, 170,
109, 58, 42, 1
Large-Size Dot Data
(=2)
Medium-Size
Dot Data (=90)
Generate Intermediate
Data of Medium-Size
Dot(2+90=92)
(b)
255, 212, 177, 170,
109, 58, 42, 1
Small-Size Dot
Data(=32)
Generate Intermediate
Data of Small-Size
Dot(92+32=124)
(c)
255, 212, 177, 170,
109, 58, 42, 1

Fig.28

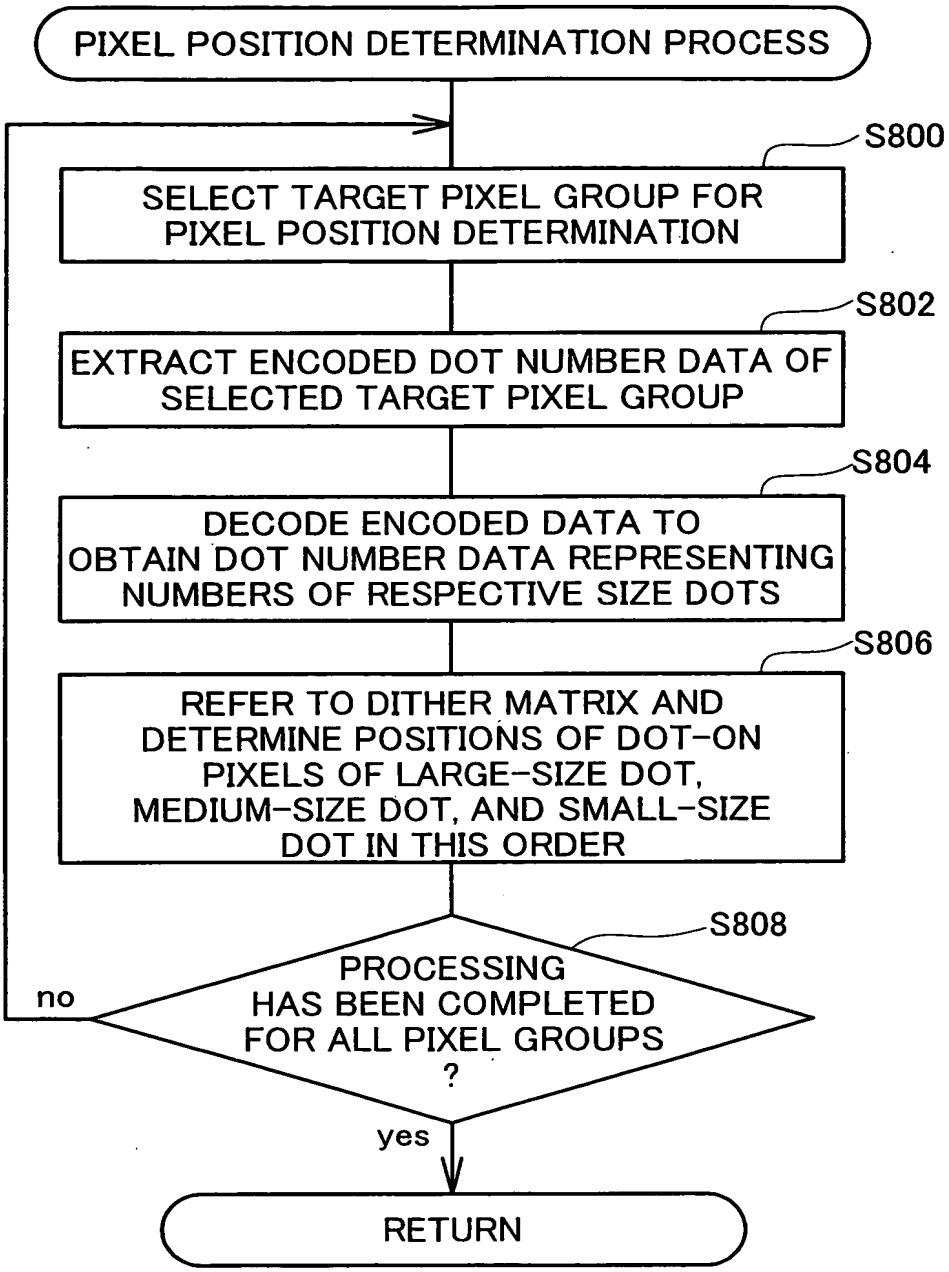

PIXEL POSITION DETERMINATION PROCESS
S800
SELECT TARGET PIXEL GROUP FOR PIXEL POSITION DETERMINATION
S802
EXTRACT ENCODED DOT NUMBER DATA OF SELECTED TARGET PIXEL GROUP
S804
DECODE ENCODED DATA TO OBTAIN DOT NUMBER DATA REPRESENTING NUMBERS OF RESPECTIVE SIZE DOTS
S806
REFER TO DITHER MATRIX AND DETERMINE POSITIONS OF DOT-ON PIXELS OF LARGE-SIZE DOT, MEDIUM-SIZE DOT, AND SMALL-SIZE DOT IN THIS ORDER
S808
PROCESSING HAS BEEN COMPLETED FOR ALL PIXEL GROUPS ?
no
yes
RETURN

Fig.29

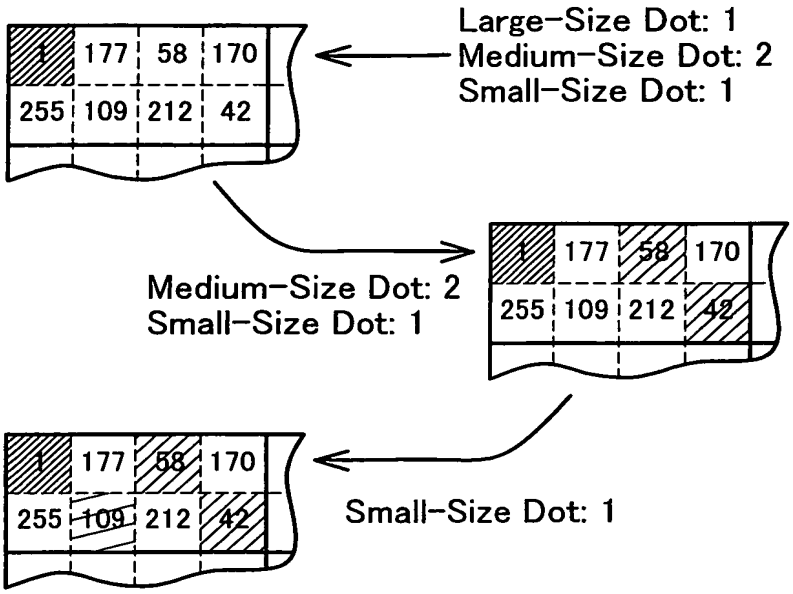


Fig.30

	Dot Numbers (Threshold Value of Each Kind of Dot)		
Code Number	Large-Size Dot (THL)	Large-Size Dot + Medium-Size Dot (THm)	Large-Size Dot + Medium-Size Dot + Small-Size Dot(THs)
0	0	0	0
1	0	0	1
2	0	0	2
3	0	0	3
160	6	8	8
161	7	7	7
162	7	7	8
163	7	8	8
164	8	8	8

Fig.31

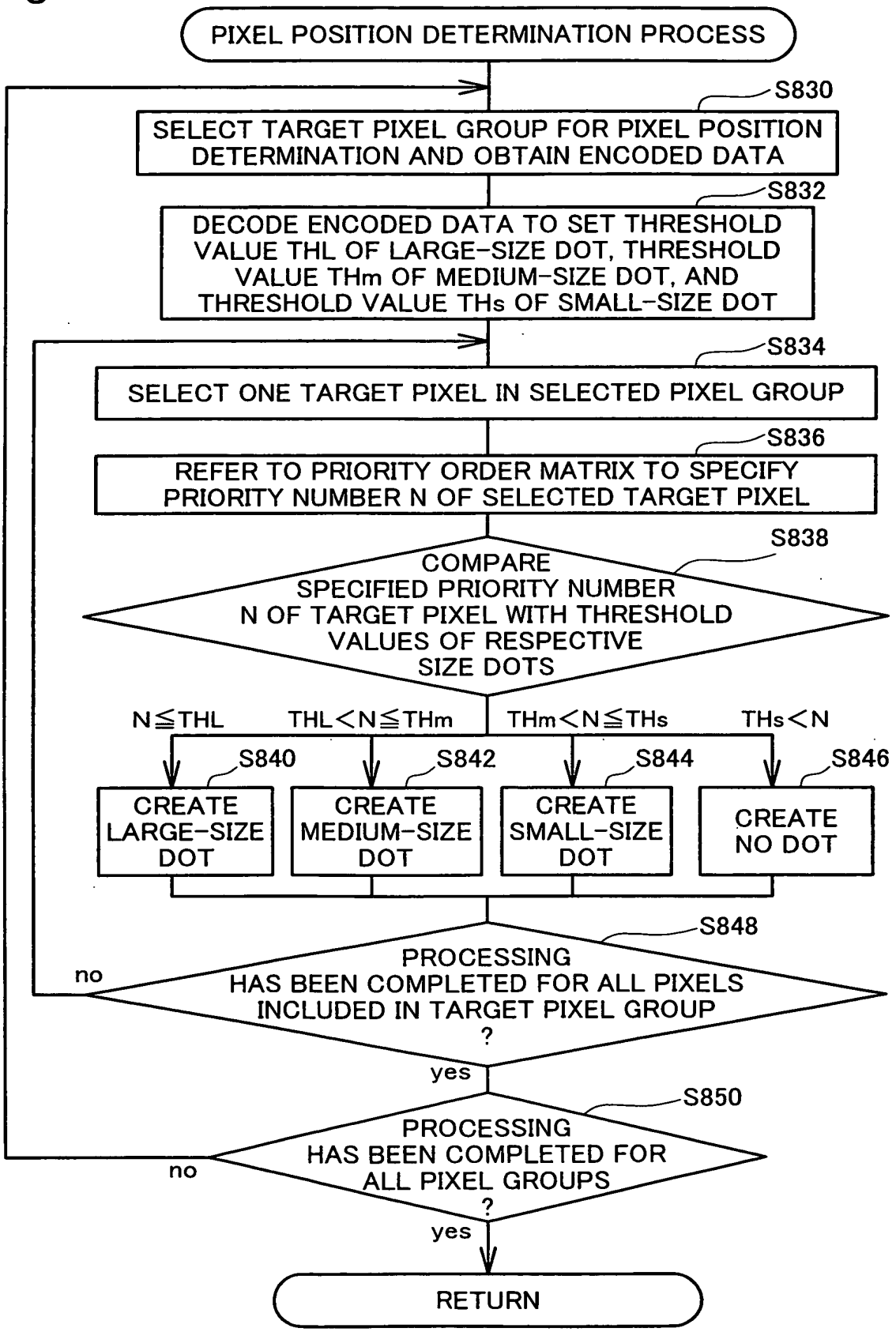

PIXEL POSITION DETERMINATION PROCESS
S830
SELECT TARGET PIXEL GROUP FOR PIXEL POSITION DETERMINATION AND OBTAIN ENCODED DATA
S832
DECODE ENCODED DATA TO SET THRESHOLD VALUE THL OF LARGE-SIZE DOT, THRESHOLD VALUE THm OF MEDIUM-SIZE DOT, AND THRESHOLD VALUE THs OF SMALL-SIZE DOT
S834
SELECT ONE TARGET PIXEL IN SELECTED PIXEL GROUP
S836
REFER TO PRIORITY ORDER MATRIX TO SPECIFY PRIORITY NUMBER N OF SELECTED TARGET PIXEL
S838
COMPARE SPECIFIED PRIORITY NUMBER N OF TARGET PIXEL WITH THRESHOLD VALUES OF RESPECTIVE SIZE DOTS
N≦THL
THL<N≦THm
THm<N≦THs
THs<N
S840
CREATE LARGE-SIZE DOT
S842
CREATE MEDIUM-SIZE DOT
S844
CREATE SMALL-SIZE DOT
S846
CREATE NO DOT
S848
PROCESSING HAS BEEN COMPLETED FOR ALL PIXELS INCLUDED IN TARGET PIXEL GROUP ?
no
yes
S850
PROCESSING HAS BEEN COMPLETED FOR ALL PIXEL GROUPS ?
no
yes
RETURN

Fig.32

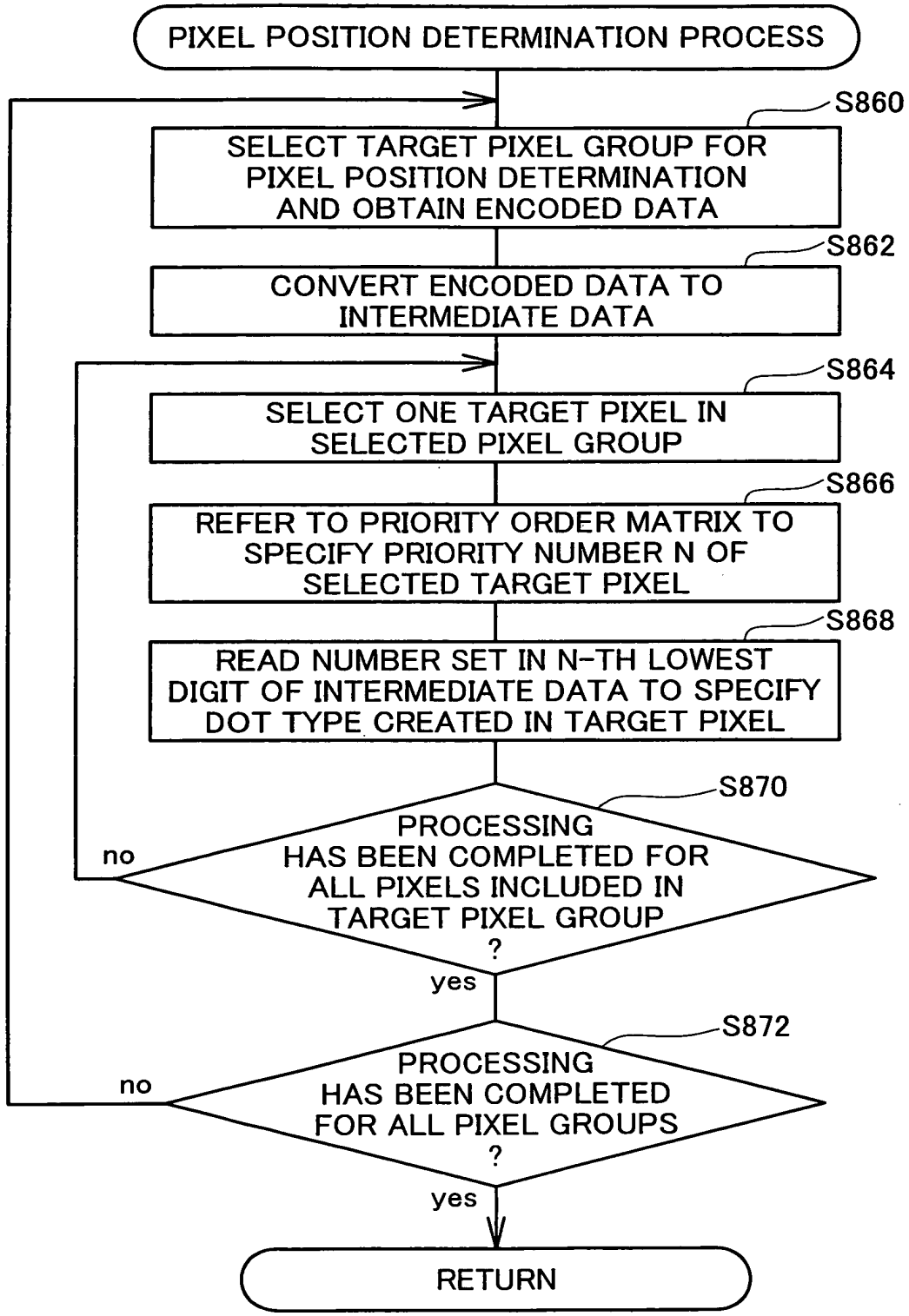

PIXEL POSITION DETERMINATION PROCESS
S860
SELECT TARGET PIXEL GROUP FOR PIXEL POSITION DETERMINATION AND OBTAIN ENCODED DATA
S862
CONVERT ENCODED DATA TO INTERMEDIATE DATA
S864
SELECT ONE TARGET PIXEL IN SELECTED PIXEL GROUP
S866
REFER TO PRIORITY ORDER MATRIX TO SPECIFY PRIORITY NUMBER N OF SELECTED TARGET PIXEL
S868
READ NUMBER SET IN N-TH LOWEST DIGIT OF INTERMEDIATE DATA TO SPECIFY DOT TYPE CREATED IN TARGET PIXEL
S870
PROCESSING HAS BEEN COMPLETED FOR ALL PIXELS INCLUDED IN TARGET PIXEL GROUP ?
no
yes
S872
PROCESSING HAS BEEN COMPLETED FOR ALL PIXEL GROUPS ?
no
yes
RETURN

Fig.33

Cod Number	Intermediate Data	Corresponding Dot Numbers		
		Large-Size Dot	Medium-Size Dot	Small-Size Dot
0	00000000	0	0	0
1	00000001	0	0	1
2	00000011	0	0	2
3	00000111	0	0	3
160	22333333	6	2	0
161	03333333	7	0	0
162	13333333	7	0	1
163	23333333	7	1	0
164	33333333	8	0	0

Fig.34(a)

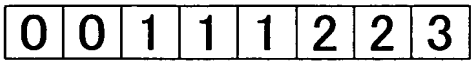


Fig.34(b)

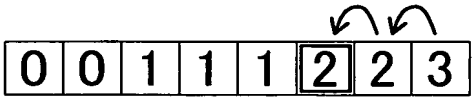


Fig.34(c)

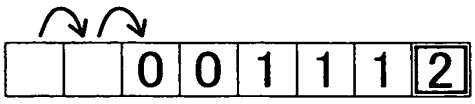


Fig.35

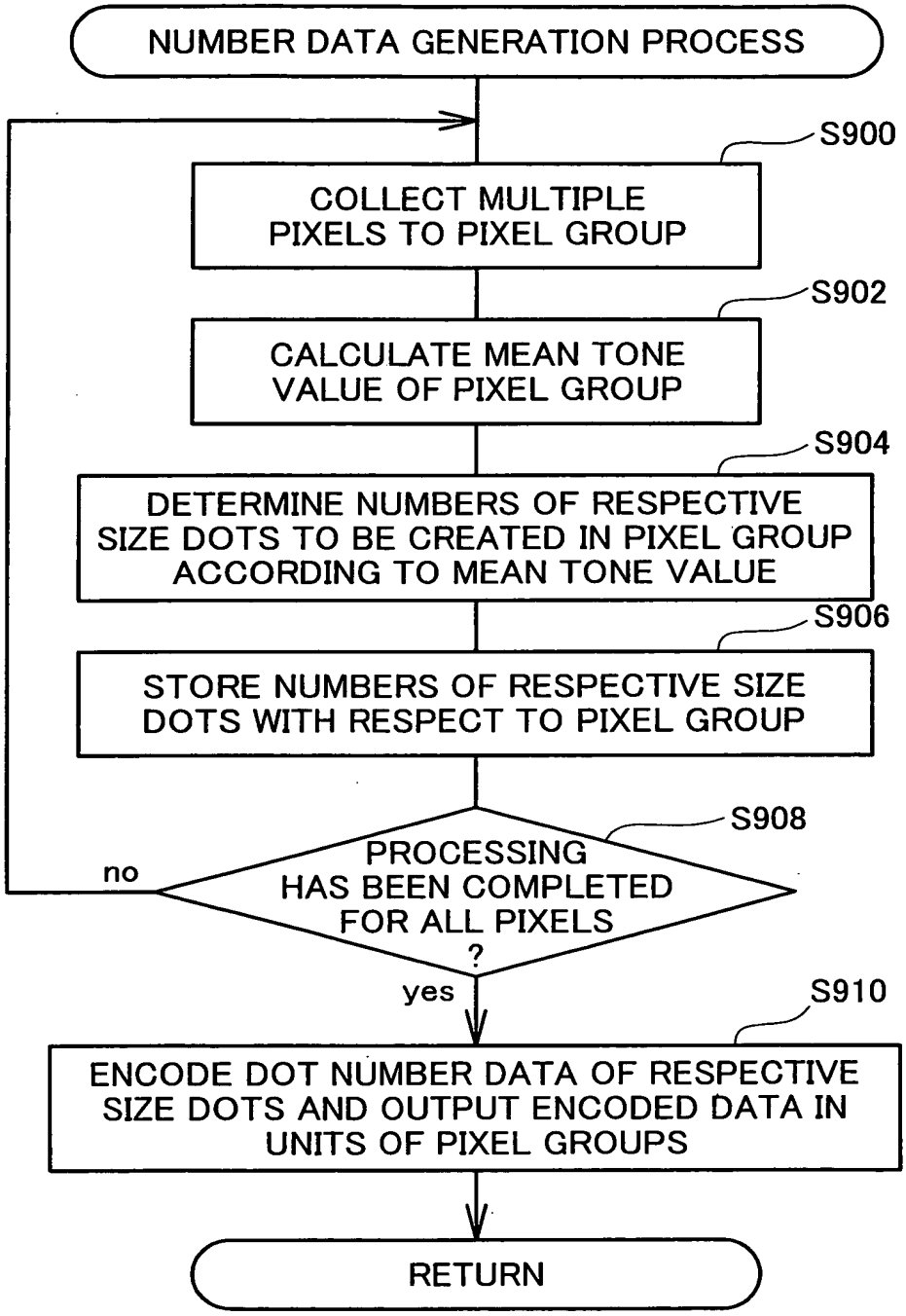

NUMBER DATA GENERATION PROCESS
S900
COLLECT MULTIPLE PIXELS TO PIXEL GROUP
S902
CALCULATE MEAN TONE VALUE OF PIXEL GROUP
S904
DETERMINE NUMBERS OF RESPECTIVE SIZE DOTS TO BE CREATED IN PIXEL GROUP ACCORDING TO MEAN TONE VALUE
S906
STORE NUMBERS OF RESPECTIVE SIZE DOTS WITH RESPECT TO PIXEL GROUP
S908
PROCESSING HAS BEEN COMPLETED FOR ALL PIXELS ?
no
yes
S910
ENCODE DOT NUMBER DATA OF RESPECTIVE SIZE DOTS AND OUTPUT ENCODED DATA IN UNITS OF PIXEL GROUPS
RETURN

Fig.36

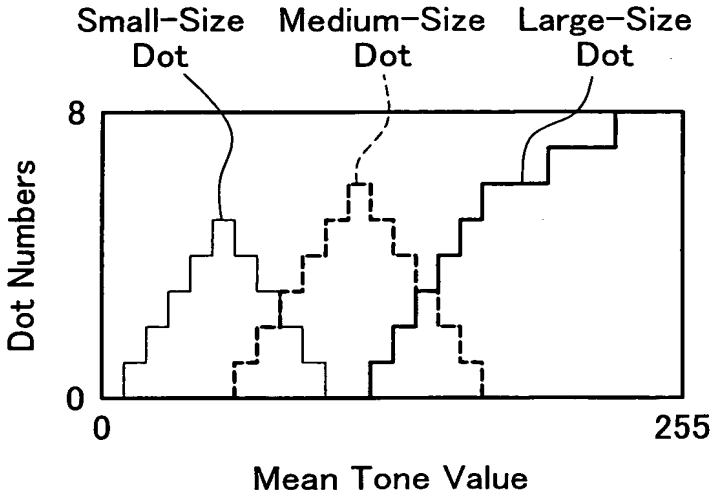

Small-Size Dot
Medium-Size Dot
Large-Size Dot
8
0
Dot Numbers
0
255
Mean Tone Value

Fig.37

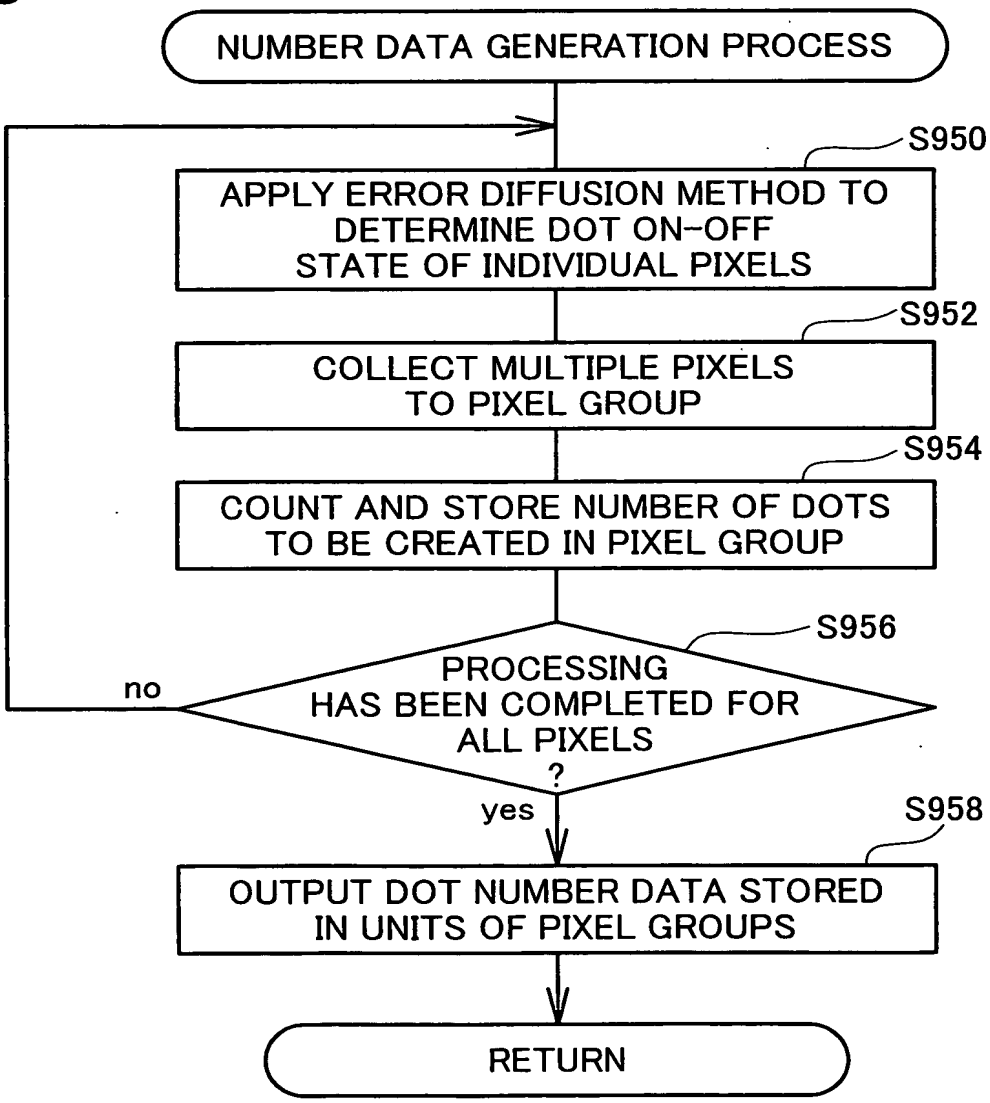

NUMBER DATA GENERATION PROCESS
S950
APPLY ERROR DIFFUSION METHOD TO DETERMINE DOT ON-OFF STATE OF INDIVIDUAL PIXELS
S952
COLLECT MULTIPLE PIXELS TO PIXEL GROUP
S954
COUNT AND STORE NUMBER OF DOTS TO BE CREATED IN PIXEL GROUP
S956
PROCESSING HAS BEEN COMPLETED FOR ALL PIXELS ?
no
yes
S958
OUTPUT DOT NUMBER DATA STORED IN UNITS OF PIXEL GROUPS
RETURN

Fig.38

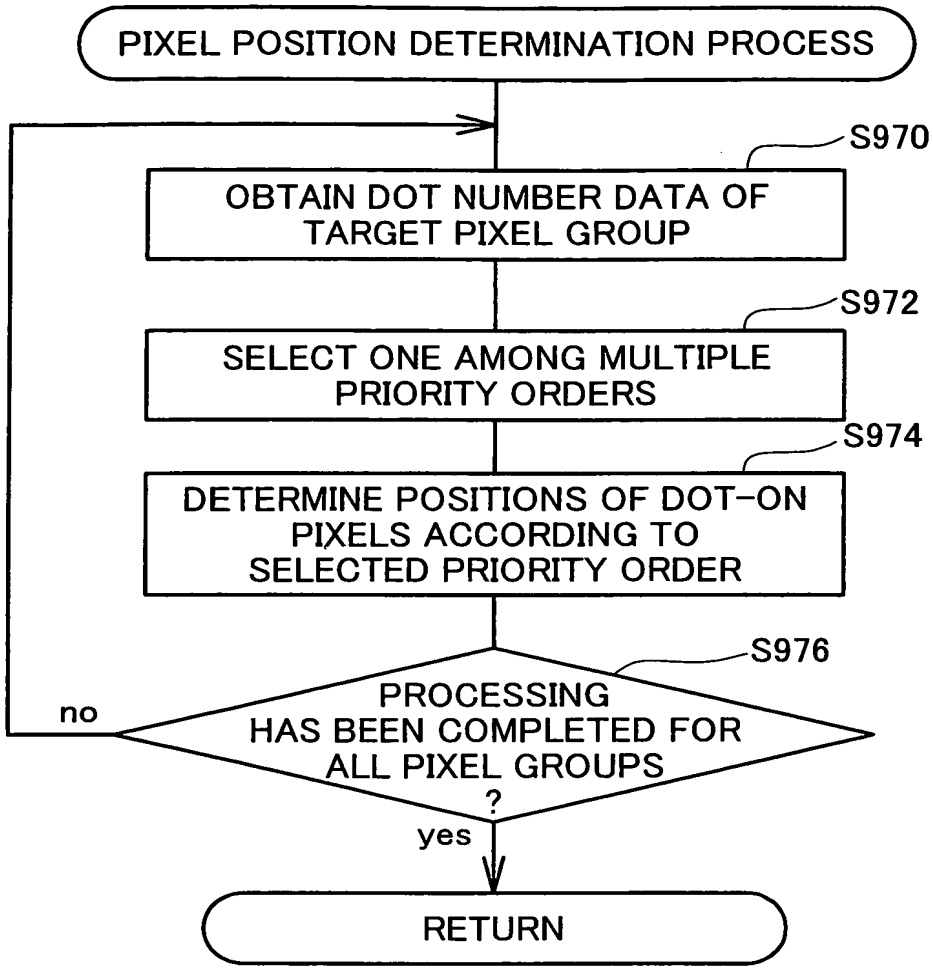
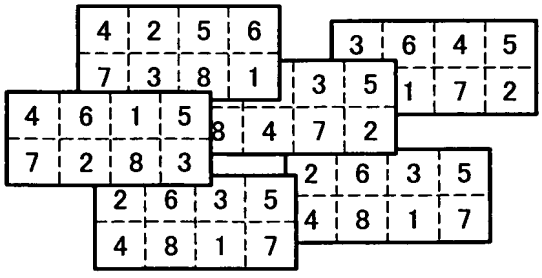

PIXEL POSITION DETERMINATION PROCESS
S970
OBTAIN DOT NUMBER DATA OF TARGET PIXEL GROUP
S972
SELECT ONE AMONG MULTIPLE PRIORITY ORDERS
S974
DETERMINE POSITIONS OF DOT-ON PIXELS ACCORDING TO SELECTED PRIORITY ORDER
S976
PROCESSING HAS BEEN COMPLETED FOR ALL PIXEL GROUPS ?
no
yes
RETURN

Fig.39


4 2 5 6
7 3 8 1
3 6 4 5
3 5 1 7 2
4 6 1 5
8 4 7 2
7 2 8 3
2 6 3 5
2 6 3 5
4 8 1 7
4 8 1 7